DRAFT Multiple Discharger Variance for Mercury in the Willamette Basin

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DEQ
State of Oregon
Department of Environmental Quality

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1. Introduction and Background

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4. It will provide information to the public and the regulated community regarding how DEQ plans to implement the MDV.

1.1 Mercury in the Environment

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[redacted] activity. In Oregon, mercury was mined commercially and used extensively in gold and silver amalgamation (Brooks, 1971; Park and Curtis, 1997). Mercury has been used historically in fungicide formulations and can still be found in many commercial products including fluorescent lights, thermometers, thermostats, automobile switches and dental amalgam. Mercury is also naturally present in vegetation and fossil fuels such as coal, natural gas, diesel fuel and heating oil. The mercury present in these fuel sources is released into the atmosphere upon combustion. This atmospheric mercury can be transported great distances and is known to be deposited on the landscape via wet and dry deposition (Sweet *et al*., 1999, 2003). Additional information on atmospheric deposition of mercury is provided in Section 3 of this document.

Mercury can be present in various physical and chemical forms in the environment (Ullrich *et al.,* 2001; USEPA, 2001b). The majority of the mercury found in the environment is an inorganic form, but it can be converted to methylmercury by certain anaerobic bacteria. Methylmercury production is affected by a host of physical and chemical factors including temperature, redox potential, dissolved oxygen levels, organic carbon, sulfate concentration and pH. Methylmercury represents the most bioaccumulative form of mercury in fish tissue and the most toxic form of mercury for human consumers (USEPA, 2001a). As a result, Oregon's human health criterion for mercury is based on a concentration of methylmercury in fish tissue.

1.2 Oregon's Mercury Water Quality Standard and its Application in the Willamette Basin

In 2011, Oregon adopted a fish tissue criterion for methylmercury based on a fish consumption rate of 175 grams/day to protect the health of high consumers of marine and freshwater fish and other seafood. The current human health criterion is 0.04 mg/kg methylmercury in the fish tissue. DEQ revised all the state's human health criteria based on the new fish consumption rate at that

[1] http://www.oregon.gov/deq/FilterDocs/chpt3mercury.pdf
[2] https://www.epa.gov/wqc/human-health-criteria-methylmercury

time. The EQC and interested stakeholders understood that meeting some of the toxics criteria

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In 2003, Oregon adopted a fish tissue criterion for methylmercury based on a fish consumption rate of 17.5 g/day and DEQ used this criterion as the target for a mercury TMDL completed in 2006. EPA did not act on the 2003 criterion until 2010, when it disapproved the criterion. By this time, DEQ was conducting a rulemaking to update all the human health criteria based on an increased fish consumption rate of 175 grams/day. The revised methylmercury fish tissue criterion was adopted in 2011 and was approved by EPA.

The 2006 TMDL development generated a bio-accumulation factor for the Willamette River for several species of fish. The BAF is used to convert fish tissue criteria value to a water column criterion. In addition, the TMDL developed a translator to convert the dissolved methylmercury to a total mercury in water, which is the mercury parameter typically monitored and used in permit analyses. Using these procedures, the TMDL derived water column targets for total mercury in ng/L based on the BAF for the most sensitive species modelled, the Northern pikeminnow (*Ptychocheilus oregonensis)*.

In 2018, during the process to revise the mercury TMDL, an EPA contractor conducted the modelling needed to update the water concentration value based on the new methylmercury criterion of 0.04 mg/kg. The revised water column concentration of 0.14 ng/L total mercury is being used to update the TMDL and to evaluate whether a discharge could cause or contribute to

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[6] OAR 340-041-8033, Table 30

2.1 The methylmercury criterion for fish consumption

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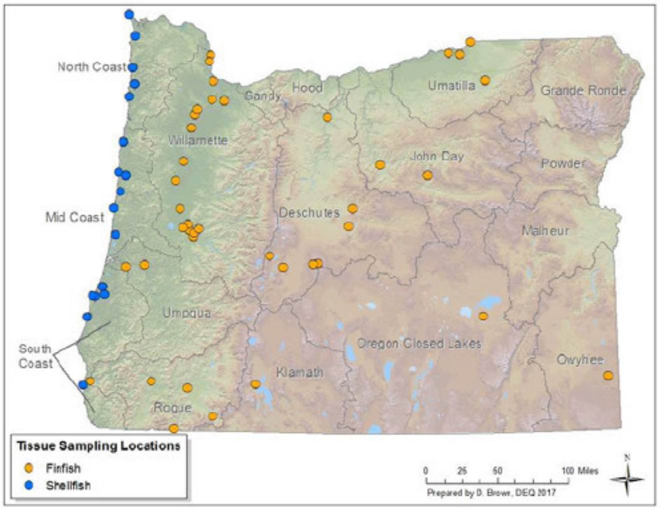

Figure 2-1. Tissue sampling sites (2008-2015) From DEQ's Statewide Aquatic Tissue Toxics Assessment Report (ODEQ, 2017, p 2)

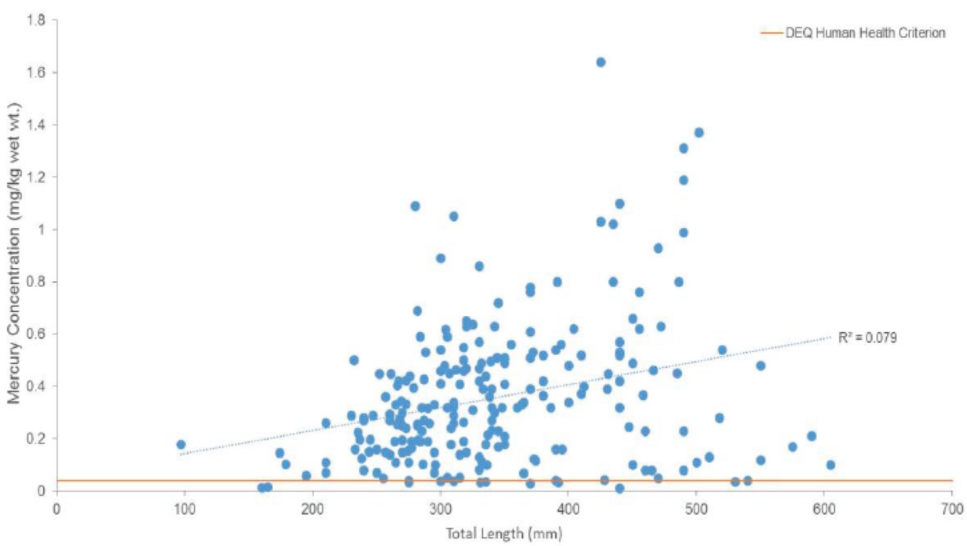

Figure 2-2. Mercury concentration (mg/kg wet weight) in skinless finfish fillets compared to total length (mm) The orange line indicates the DEQ human health criterion for methylmercury (0 04 mg/kg fish tissue) (ODEQ, 2017, p 13, Figure 10)

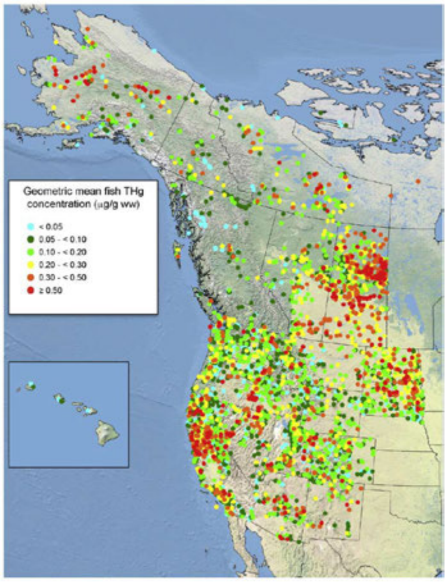

Figure 2-3. Geometric mean of fish tissue concentrations by site Note that µg/g is equal to mg/kg Only locations with turquoise dots would have geometric means close to the 0 04 mg/kg standard From Eagles-Smith et al , 2016b (Figure 9)

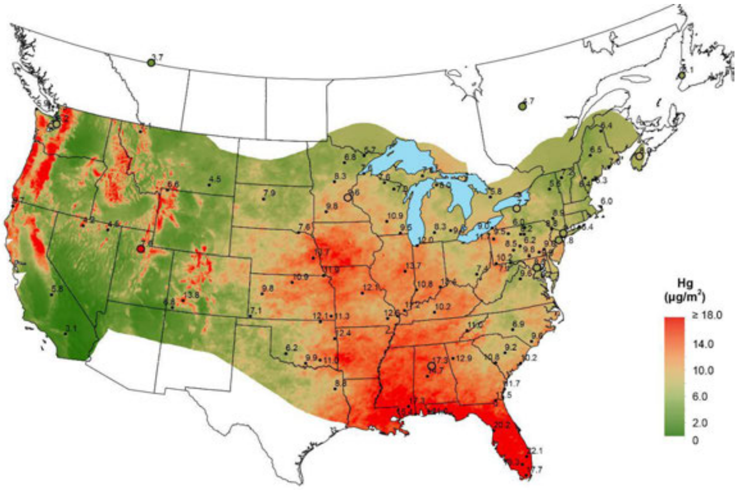

Figure 2-4. Total Mercury Wet Deposition in 2014 (Mercury Deposition Network, 2017)

2.2 Water Quality Based Effluent Limits for mercury are not achievable

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Therefore, NPDES permits limits for mercury are evaluated based on the water quality criterion. Because total mercury levels in the Willamette River basin exceed the water concentration needed to meet the methylmercury criterion, dischargers would be required to achieve an effluent concentration equal to the water concentration target of 0.14 ng/L before the effluent is discharged to the receiving water. As demonstrated below, DEQ has determined that there are currently no feasible treatment technologies that could reduce mercury levels enough to achieve an effluent concentration of 0.14 ng/L.

2.2.1 Mercury Removal Achieved by Municipal Treatment Technologies

This section presents data on mercury levels achieved by municipal treatment systems in Oregon and California. In 2005, California performed a study looking at methylmercury removal from NPDES permitted dischargers in the Sacramento River Delta[11]. California required dischargers to collect and report on methylmercury influent and effluent data over twelve months in 2004 and 2005. A subset of these facilities also reported total mercury effluent data. A summary of annual average total mercury effluent concentrations is shown in Figure 3-5. The facilities were categorized as either secondary or tertiary treatment plants. The median of the average annual total mercury effluent concentrations was 7.4 ng/L in secondary treatment plants (n=27) and ranged from 3.1-21.5 ng/L. In tertiary treatment plants (n=22), the median average annual concentration was 3.3 ng/L and ranged from 0.8 – 11.6 ng/L.

DEQ also compiled and analyzed mercury levels from 2016 data provided by municipal dischargers in Oregon (Figure 3-6). In this case, DEQ categorized each system as secondary or advanced. Advanced systems included any in which additional filtration or treatment was installed after secondary treatment. The median average annual total mercury effluent concentration was 2.9 ng/L for secondary treatment plants (n=11) and ranged from 1.2 to 8.3 ng/L. In advanced treatment plants (i.e., those employing nutrient removal, tertiary or other post-secondary treatment filtration, or both) (n=8), the median annual average concentration was 1.7 ng/L and ranged from 1.1 to 3.0 ng/L. The Oregon data comes from the state's larger facilities, which have a pre-treatment program and have implemented source control programs for several to many years. The California data comes from both large and small systems, is 12 years older than the Oregon data, and comes from the Sacramento River Delta, which has high mercury levels resulting from historical gold mining. These facts may explain why Oregon effluent data has considerably lower concentrations than that from California.

[11] California EPA, Regional Water Quality Control Board, Central Valley Region. 2010. Staff Report: A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley.

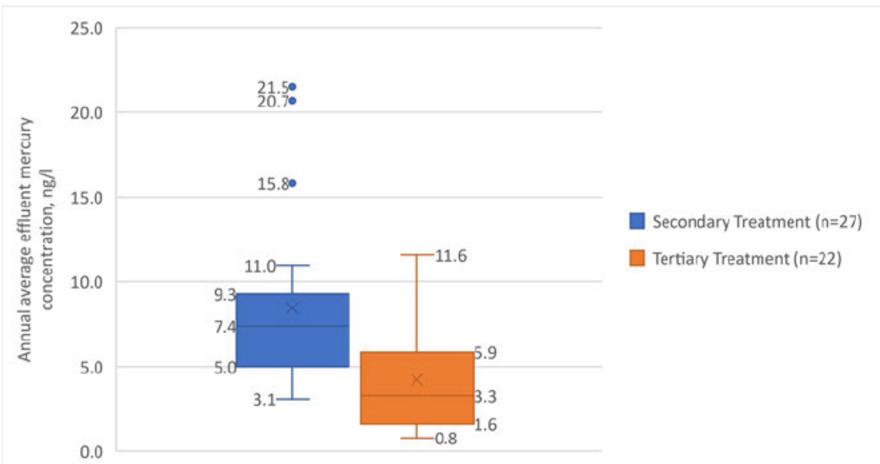

Figure 2-5. Average Total Mercury Effluent Concentration, Sacramento Delta WWTPs, 2004-5. Source: California EPA, Regional Water Quality Control Board, Central Valley Region. 2010. Staff Report: A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley.

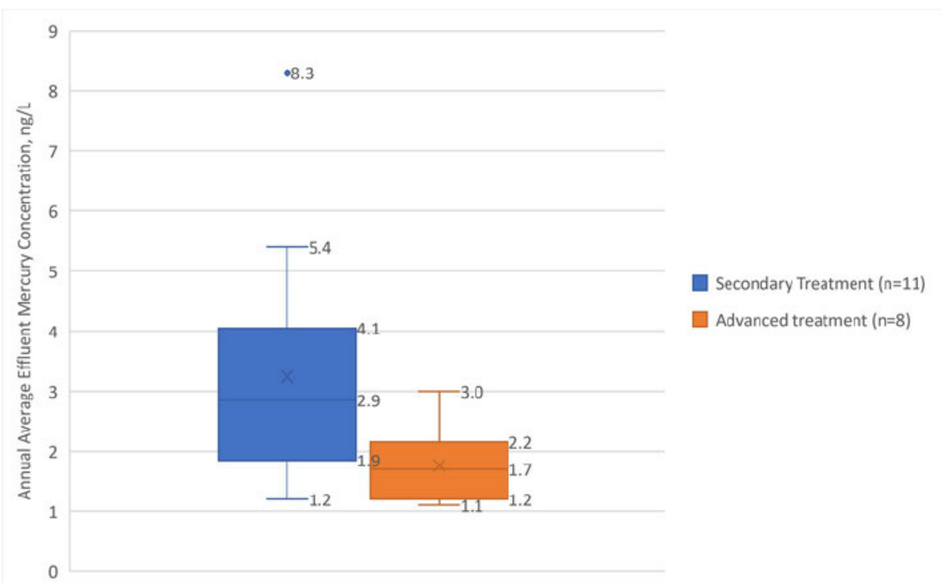

Figure 2-6. Average Total Mercury Effluent Concentrations, Oregon pre-treatment WWTPs, 2016

Note: The Oregon wastewater treatment facilities included in the advance treatment group (n=8) for this graphic include: Rock Creek and Durham operated by Clean Water Services, McMinnville, Wilsonville, Albany, Kellogg Creek, Newberg and Tri-cities. Only a portion of the Tri-cities WWTP flow is filtered after secondary treatment; however, the average mercury concentration in effluent in 2016 was 1.6 ng/L, which is comparable to other advanced systems.

2.2.2 Review of Available Treatment Technologies

In variance applications for individual variances, Clean Water Services, which operates four wastewater treatment plants in the Willamette Basin, provided the results of a literature review on the ability of available treatment technologies to remove mercury. CWS noted that their literature review did not identify pilot or full-scale treatment systems that would be able to achieve the 2006 TMDL target of 0.92 ng/L, nor the lower water concentration target from the

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[12] Ohio Environmental Protection Agency. 1997. Assessing the Economic Impacts of the Proposed Ohio EPA Water Rules on the Economy. Prepared for the Division of Surface Water by Foster Wheeler Environmental Corporation and DRI/McGraw Hill.
[13] Treatment Technology Review and Assessment, Association of Washington Businesses, HDR, Dec. 2013.

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A 2007 EPA report regarding mercury treatment notes that there are technologies, such as precipitation, filtration or other physical/chemical treatments (see Table 3-1) that might treat mercury in addition to those typically employed by wastewater treatment plants. However, these have been employed in industrial settings where influent concentrations were an order of magnitude higher than influent concentrations at municipal wastewater treatment facilities[15]. The effluent concentrations at many of these industrial applications were similar to the influent concentrations at municipal treatment facilities. Moreover, the information provided in the EPA report did not indicate flow volumes, so it is difficult to translate these studies to typically larger municipal wastewater treatment plant volumes.

In another study, an oil refinery evaluated various treatment technologies for wastewater with low (10 ng/L) mercury levels to determine the extent to which mercury concentrations could be further reduced using conventional treatment. Bench scale tests of various adsorbent techniques showed that they could remove mercury to as low as less than 0.08 ng/L of total mercury[16]. Ultra- and micro-filtration tests also reduced mercury to less than 1 ng/L, although not as much as adsorption. However, such techniques have not been shown to work at the higher volume or

[14] Michigan Department of Environmental Quality. 2015. Mercury Multiple Discharge Variance Document.
[15] U.S. EPA. 2007. Treatment Technologies for Mercury in Soil, Waste, and Water. Office of Superfund Remediation and Technology Innovation. Washington, DC. 133 pp.
[16] Urgun-Demirtas, M, P. Gillenwater, M. C. Negri, Y. Lin, S. Snyder, R. Doctor, L. Pierece and J. Alvarado. 2013. Achieving the Great Lakes Initiative Mercury Limits in Oil Refinery Effluent. Water Environment Research 85(1): 77-86.

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Table 2-1. Potential treatment technologies considered for mercury treatment

Study	Type of treatment technology	Influent total mercury concentration (ng/L)	Average effluent total mercury concentration (ng/L)	Percent removal	
EPA (2007)[18]	Precipitation (Chelator)	400-9,600,000	25-21,400	42-99.9%	Full scale for groundwater and wastewater treatment; not tested for municipal wastewater or industrial processes in Willamette Basin
EPA (2007)[6]	Adsorption/ Granular Activated Carbon	3,300-2,500,000	300-1,000	99-99.8%%	Full scale
HDR Study (2013)[19]	Tertiary Microfiltration/ Reverse Osmosis		0.12-1.2 hypothetically	>99%	Not demonstrated at WWTP scale
HDR Study (2013)	Tertiary Microfiltration/ Granular Activated Carbon		0.12-1.2 hypothetically	>99%	Not demonstrated at WWTP scale

[17] Treatment Technology Review and Assessment, Association of Washington Businesses, HDR, Dec. 2013.
[18] U.S. Environmental Protection Agency. 2007. Treatment Technologies for Mercury in Soil, Waste, and Water. Office of Superfund Remediation and Technology Innovation. Washington, DC. 133 pp.
[19] HDR. 2013. Treatment Technology Review and Assessment. Prepared for the Association of Washington Businesses.

Urgun-Demirtas, et al. (2013)[20]	Precipitation	10 ng/L	3.1 ng/L (before filtration) 0.17 ng/L (after filtration)	56.5% before filtration	Bench scale testing
Urgun-Demirtas, et al. (2013)	Adsorption	10 ng/L	<0.08 ng/L – 0.72 ng/L (lowest achieved)	92.8% - 99.2%	Bench scale testing
Urgun-Demirtas, et al. (2013)	Filtration	10 ng/L	0.26 – 0.34 ng/L (lowest achieved)	65 – 97% depending on pressure	Bench scale testing
Hollerman, et al. (1999)[21]	Adsorption	739-1447 ng/L	~25-340 ng/L	n/a	Low volume

Table 2-2. Treatment capability of mercury technologies

Treatment Technology	Volume Range of Known Uses	Treatment Ability
Activated sludge	Up to 25 MGD	3-50 ng/L
Activated sludge w/ Nutrient Removal or Filtration	Up to 25 MGD	1-10 ng/L
Membrane Filtration	Low volume	Bench scale to 0.26 ng/L
Ion Exchange	0.015 MGD (5-50 GPM)	1 ng/L
Precipitation and filtration	Low volume	Bench scale to 0.17 ng/L; full scale to 25 ng/L
Adsorption	Low volume	Bench scale to 0.08 ng/L; full scale to 25 ng/L

3. Variance Requirements

[20] Urgun-Demirtas, M, P. Gillenwater, M. C. Negri, Y. Lin, S. Snyder, R. Doctor, L. Pierece and J. Alvarado. 2013. Achieving the Great Lakes Initiative Mercury Limits in Oil Refinery Effluent. Water Environment Research 85(1): 77-86.

[21] Hollerman, W., L. Holland, D. Ila, J. Hensley, G. Southworth, T. Klasson, P. Taylor, J. Johnston, and R. Turner. 1999. Results from the low level mercury sorbent test at the Oak Ridge Y-12 Plant in Tennessee. Journal of Hazardous Materials B68:193-203.

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and require the facility to develop and implement an MMP, including monitoring and reporting requirements.

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[25] The initial 5 year period varied from permit to permit.

wastewater treatment plants. According to WDNR staff, none of these facilities employ advanced treatment, but have achieved these levels through minimization.[26]

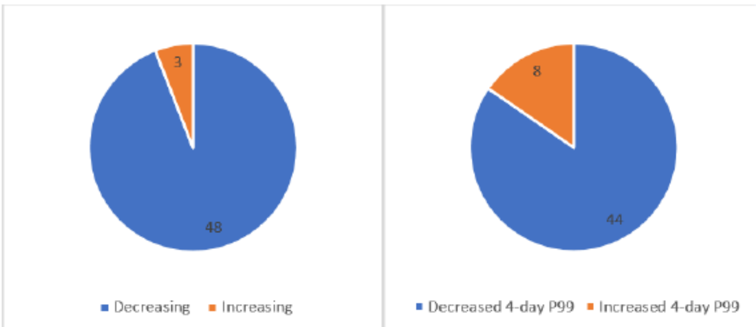

Figure 3-1. Number of Wisconsin municipal wastewater treatment systems with increasing and decreasing trends in average (left) and 4-day P99 (right) concentrations. Source: Wisconsin Department of Natural Resources.

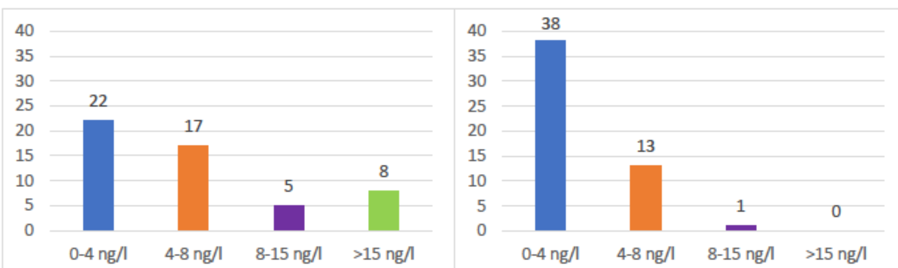

Figure 3-2. Number of Wisconsin municipal WWTPs by 4-day P99 mercury concentrations from initial five-year period (left) to most recent five-year period (right). Source: Wisconsin Department of Natural Resources.

Available data from Wisconsin also indicates an overall decreasing trend in mercury concentrations at industrial facilities. Among 24 industrial NPDES permit holders, the mean 4-day P99 decreased from 25.4 to 13.7 ng/L and the median 4-day P99 decreased from 14.1 to 7.2 ng/L. Eighteen of the 24 facilities had lower 4-day P99 concentrations in the most recent five-year period as compared to the initial period, and sixteen had decreasing average mercury concentrations (Figure 5-3). Finally, while only one additional facility had a 4-day P99 less than 8 ng/L from the initial five-year period to the most recent, five fewer facilities had concentrations greater than 15 ng/L (Figure 5-4).

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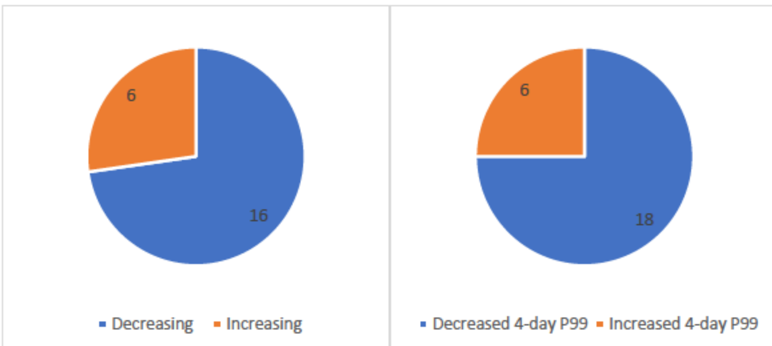

Figure 3-3. Number of Wisconsin industrial wastewater treatment systems with increasing and decreasing trends in average (left) and 4-day P99 (right) concentrations. Source: Wisconsin Department of Natural Resources.

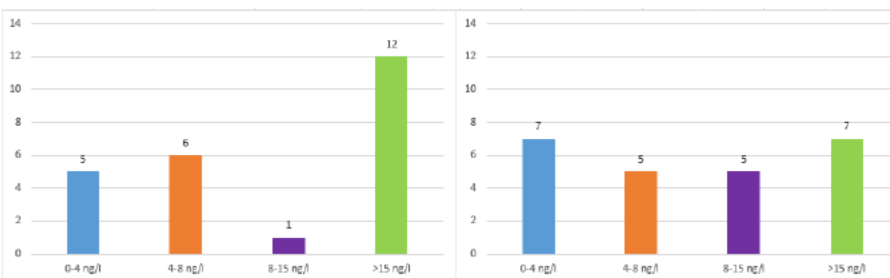

Figure 3-4. Number of Wisconsin industrial NPDES facilities by 4-day P99 mercury concentrations from initial five-year period (left) to most recent five-year period (right). Source: Wisconsin Department of Natural Resources.

Evidence from influent and biosolids data also indicates the effectiveness of MMPs in reducing mercury, even when effluent levels are variable. A decade of mercury influent data from 72 major NPDES wastewater treatment plants in Minnesota indicate that MMPs have resulted in significant and continued reductions in mercury concentrations entering treatment systems. Between 2008 and 2017, influent total mercury concentrations decreased from an average of 180 ng/L to 70 ng/L (Figure 5-5). Data from Oregon's Rock Creek Advanced Wastewater Treatment Plant operated by Clean Water Services indicates decreasing mercury levels in biosolids, showing the effectiveness of their mercury reduction efforts over the last 20 years (Figure 5-6).

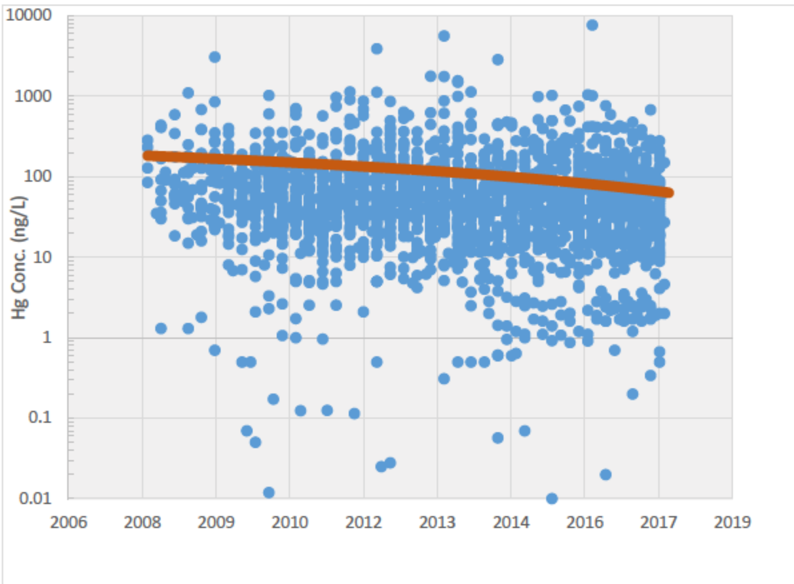

Figure 3-5. Influent Data from Major Wastewater Treatment Plants in Minnesota Source: Minnesota Pollution Control Agency

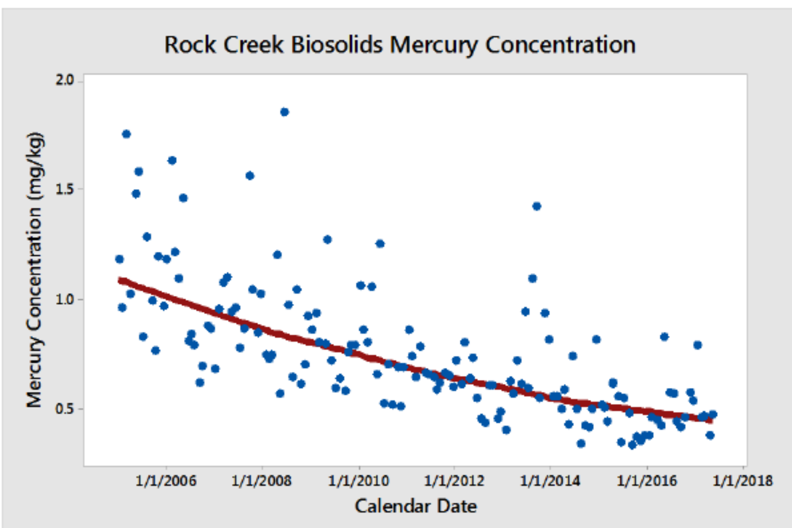

Figure 3-6. Mercury Concentrations in Biosolids, Rock Creek Wastewater Treatment Plan Source: Clean Water Services

In addition to achieving similar effluent concentrations as advanced treatment, MMP implementation, incurs less environmental harm than advanced treatment. Environmental costs associated with advanced treatment include greater energy consumption, added greenhouse gas emissions, and the need for additional waste disposal.[27]

According to a report from the Water Research Foundation and Electric Power Research Institute, daily energy consumption at advanced treatment plants is about 500-600 kwh per million gallons per day higher than that of secondary activated sludge plants.[28] Thus, for the smallest facility likely to need a variance (those with approximately 1 MGD design flow), the additional annual energy consumption to upgrade to advanced treatment is 219 megawatt-hours per year. This equates to an annual carbon footprint increase of approximately 125 metric tons carbon dioxide equivalent per year.[29] According to U.S. EPA's analysis of the social costs of one metric ton of greenhouse gas emissions in 2020 dollars ranges from $12 to $123[30]. The increased energy consumption at a smaller plant covered by the variance would have a social cost ranging from $1,500 to $15,375 per year, while having a similar outcome to source reduction. For larger facilities that may receive coverage under the variance, additional treatment could equate to as much as 5000 metric tons CO_2 equivalent per year released into the environment. Additional waste disposal required by wastewater treatment would add additional carbon footprint due to the need to haul additional material. Moreover, waste disposal could result in land application of material containing mercury, which would potentially be re-released to the environment.

The total mercury load from all point sources to rivers in the Willamette Basin is 1.6 kg/year[31], or about 1% of the total annual load of mercury to the basin. Treatment upgrades at the estimated number of facilities with higher mercury concentrations would only reduce a portion of this load, which would also likely be achieved eventually through source reduction without the associated environmental cost. Therefore, DEQ has concluded that the additional energy use and waste disposal associated with advanced treatment would cause more environmental harm than removing similar amounts of mercury load through MMPs, which focus on source reduction, even though the source reduction may take more time to achieve the comparable effluent levels.

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[27] DEQ acknowledges that treatment upgrades are sometimes necessary for reasons other than mercury removal. This possibility is incorporated into the procedure for Highest Attainable Condition described in Chapter 6.
[28] Electric Power Research Institute and Water Research Foundation. 2013. Electricity Use and Management in the Municipal Water Supply and Wastewater Industries. 194 pp.
[29] To calculate the annual carbon footprint, DEQ utilized carbon footprint information utilized in the 2019 Triple Bottom Line analysis to support the chloride and mercury variance for the city of Madison, Wisconsin.
[30] https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html
[31] Oregon Department of Environmental Quality. 2019. Draft Willamette River Total Maximum Daily Load for Mercury.

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3.2 Requirements that apply throughout the term of the variance

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3.2.1 Level Currently Achievable

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The HAC for the MDV is expressed in the federal variance rule as "the interim criterion or interim effluent condition that reflects the greatest pollutant reduction achievable with the pollutant control technologies installed at the time the State adopts the WQS variance, and the adoption and implementation of a Pollutant Minimization Program." DEQ uses the term "Level Currently Achievable" to describe "the interim effluent condition that reflects the greatest pollutant reduction achievable with the pollutant control technologies installed at the time the State adopts the WQS variance."

In order to calculate the LCA for mercury for each facility, DEQ will use the most recent five years of mercury effluent data at the time of each permit issuance, with a minimum of eight quarterly samples that span at least two years. Each sample is a single data point, even when the facility collects samples on three consecutive days, as required by the pretreatment program. The TSD methodology (Table E-1), with lognormal transformation and no auto-correlation, is used to calculate the 95th percentile of the effluent data distribution to describe the Level Currently Achievable. DEQ used data from four facilities to demonstrate how DEQ would calculate these levels (Figures 3-7 – 3-10). The LCA value is equal to the 95th percentile of the distribution shown in each chart. The figures also include the 99th percentile value for information only.

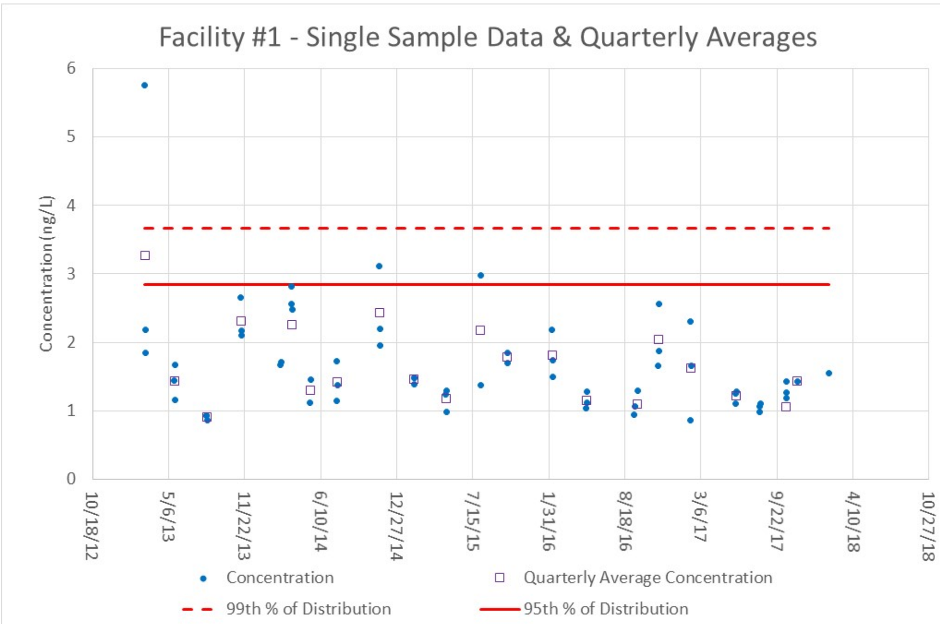

Figure 3-7. LCA (95th percentile) of hypothetical facility under the MDV. 99th percentile value shown for informational purposes.

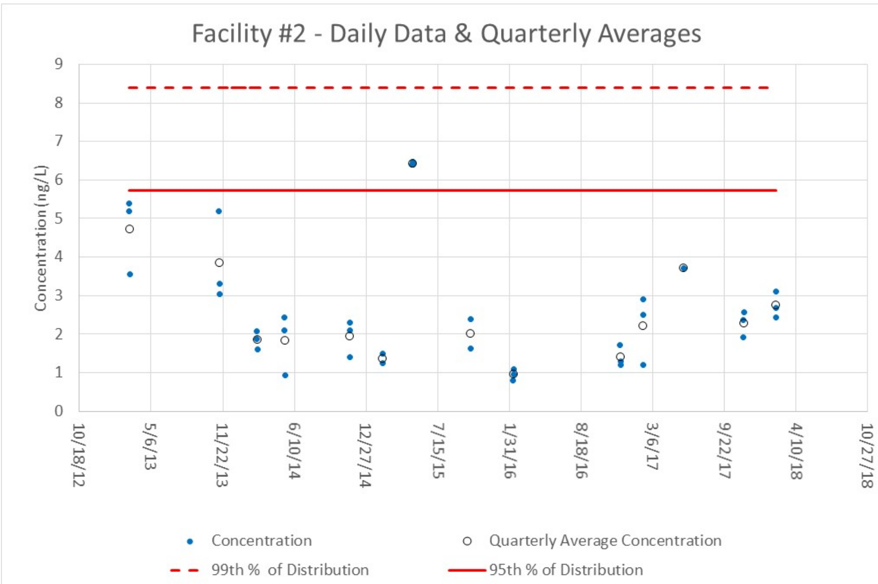

Figure 3-8. LCA (95th percentile) of hypothetical facility under the MDV. 99th percentile value shown for informational purposes.

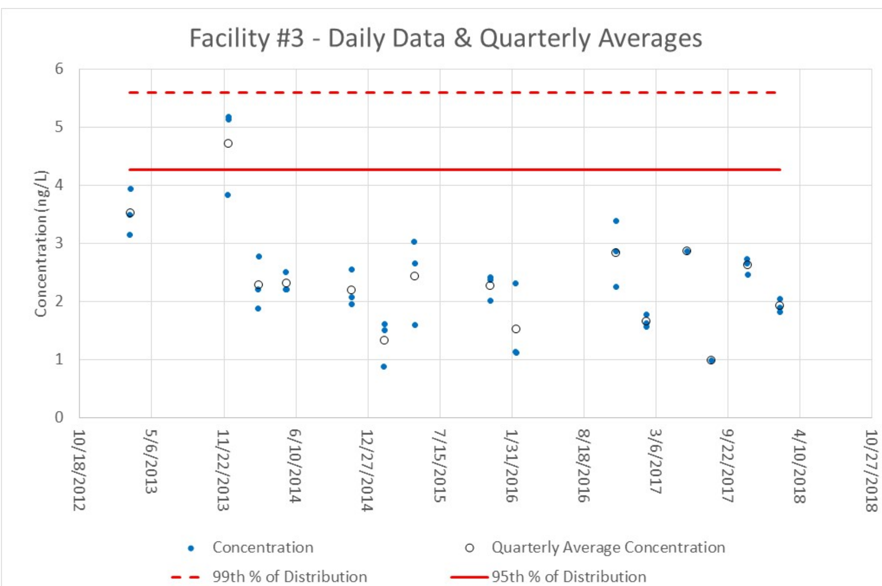

Figure 3-9. LCA (95th percentile) of hypothetical facility under the MDV. 99th percentile value shown for informational purposes.

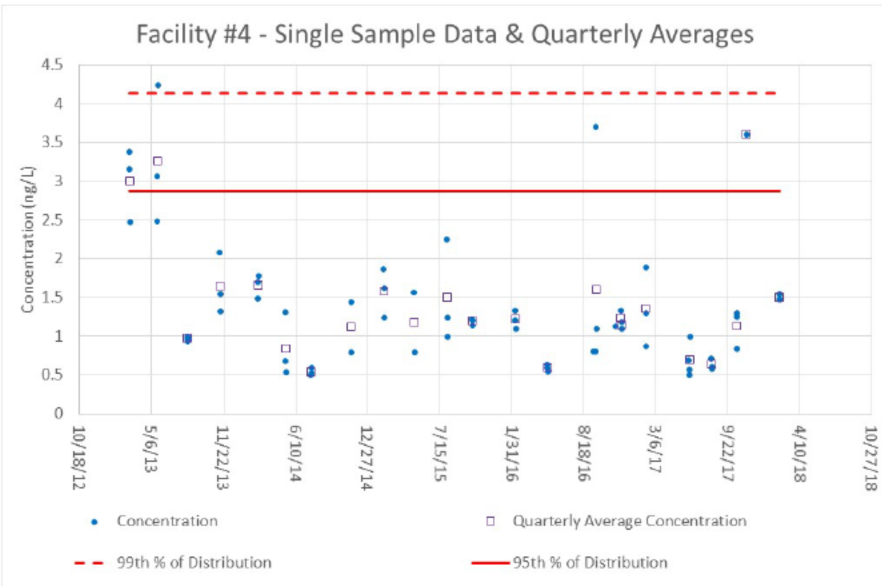

Figure 3-10. LCA (95th percentile) of hypothetical facility under the MDV. 99th percentile value shown for informational purposes.

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sources from dental offices, medical facilities, schools and other laboratories. DEQ acknowledges that, statewide, dental offices already are required to install mercury amalgam collectors, but cities may want to have an outreach program to ensure the requirements are being

[32] Oregon Department of Environmental Quality, 2010. Internal Management Directive: Implementation of Methylmercury Criterion in NPDES Permits. DEQ12-WQ-0011-IMD. Available at: https://www.oregon.gov/deq/Filtered%20Library/IMDmethylmercuryCriterion.pdf

followed and maintained. Municipalities should include some process for periodically identifying potential mercury sources outside of these areas, such as manufacturing facilities that may be in the facility's collection system that may have mercury sources. DEQ also acknowledges that different municipalities are in different stages of MMP implementation. Therefore, a municipality developing its first MMP may focus its efforts on developing an inventory of potential mercury sources, such as those from dental, medical and educational facilities; public education and outreach; and contacts with dental offices and other organizations in its inventory. A municipal facility that has been implementing an MMP for ten years or more may focus on finding lesser known sources and maintaining its current outreach efforts.

For industrial facilities, the draft rule recommends that MMP activities address mercury-containing materials used in a facility's manufacturing process and/or testing laboratories, as well as a process for identifying other potential mercury sources.

For all facilities, the MMP should describe any monitoring that will be conducted, including compliance monitoring under the permit.

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3.4 Re-evaluation of the Highest Attainable Condition

[33] 40 CFR 131 14(b)(1)(iv)

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Each permittee shall provide the following information:

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4.2.1 Effluent limit based on the Level Currently Achievable

DEQ will include an interim effluent limit in each permit based on the LCA procedure described in Section 3.2.1. These permit limits will apply as a quarterly average concentration, not to be exceeded in 2 consecutive quarters.

Because many facilities sample mercury just once per quarter, a spike in mercury concentrations could cause an exceedance of the quarterly average, while not being indicative of a problem in treatment operations. Therefore, it is not appropriate to set a permit limit based upon the sampling results for a single quarter. Instead, DEQ proposes to define a violation of the maximum quarterly average permit limit as two consecutive quarters in which the quarterly average is above the 95th percentile of the distribution. Thus, one quarterly average above the 95th percentile is not a permit violation. However, if the quarterly average is above the 95th percentile again in the following sampling period, then the limit has been exceeded.

Most facilities that sample for mercury do so as part of their pretreatment programs. This sampling is typically conducted on three consecutive days, once per quarter. DEQ does not propose additional sampling. However, DEQ allows additional samples. If additional samples are collected, the results must be included when calculating the quarterly average.

4.2.2 Monitoring requirements

DEQ will incorporate effluent monitoring requirements into the permit to ensure compliance with the LCA-based interim effluent limit. DEQ will require a minimum of quarterly mercury effluent monitoring for each facility. Many facilities already collect at least this much mercury effluent data under pre-treatment programs or current permit requirements.

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4.2.4 Annual progress reports

The permit will require an annual progress report. The progress report should include, at a minimum, the following information:

- All effluent, influent, biosolids and other mercury data collected over the course of each year of the permit cycle;
- A summary of activities conducted under the MMP; and
- Any nonpoint source best management practices implemented under the authority of the permittee to address mercury loads.

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4.2.6 Re-evaluation of requirements during permit renewal

When each permit is renewed, DEQ will re-calculate the LCA based on effluent data collected during the previous five years and incorporate that information into the permit fact sheet. DEQ then will establish an updated interim effluent limit based on the more recent data, as described in Section 4.2.1. Moreover, DEQ will require each facility to update their MMP to provide more specificity to activities that will be conducted for the duration of the permit, as well as in future permit terms, if warranted. The public will have the opportunity to provide comment on the updated MMP and permit requirements during the permit renewal process.

5. Bibliography

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